Analysis of Pyrocumulonimbus Events across Western Canada during the 2025 Canadian Wildfire Season

Maya Desrochers[1], John Hanesiak[1], and Kyle Ziolkowski[2]

[1]University of Manitoba, [2]Environment and Climate Change Canada

1. BACKGROUND

- Over **8.9 million ha** of land **burned in Canada** during the **2025 wildfire season**

- Most of these wildfires occurred in the **boreal forest**

- Much of the boreal forest lies **outside of radar coverage**

WHAT ARE PYROCUMULONIMBUS CLOUDS?

- **Pyrocumulonimbus (pyroCb) clouds are fire-induced thunderstorms,** caused by **large wildfires**

- Create hazardous conditions:
  - **Lightning**
  - **Strong winds**
  - **Little to no rain**

2. OBJECTIVES

1) **Better understand the environmental conditions that precede pyroCb formation**

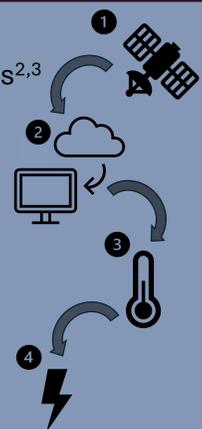2) **Characterize the typical lightning environments of pyroCbs**

WHY?

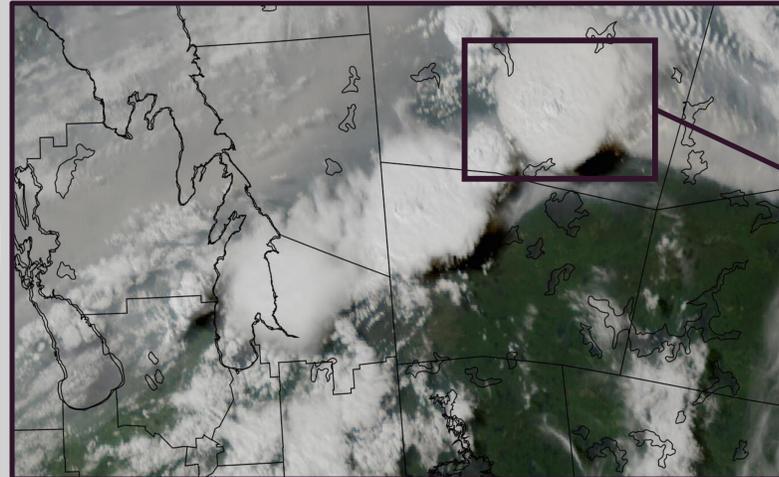- Emphasize the need for an improved detection method

3. METHODS

1) **Analyze GOES-18 and 19 imagery** and data from an **online discussion group** to identify potential pyroCbs[2,3]

2) Run imagery through a **python-based detection algorithm** to confirm occurrence[4]

3) Use **ERA5 reanalysis data** to analyze temperature, wind speeds, relative humidity, and CAPE[5]

4) Utilize **lightning data from the CLDN** to examine the type, polarity, and density of lightning produced[6]
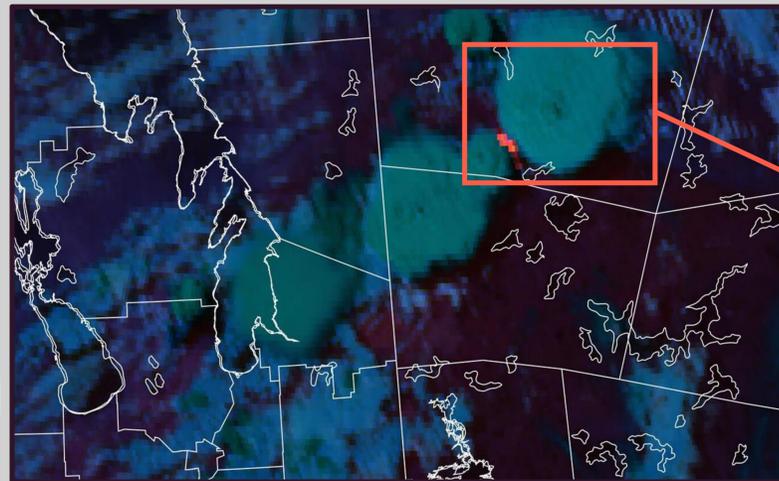
4. PRELIMINARY RESULTS

Figure 1a. GOES-19 (East) satellite imagery of a mature-stage thunderstorm southeast of Pikangikum, ON (51.58°N, 93.81°W), on July 10, 2025, at 21:00 UTC. Satellite imagery is overlaid with a GeoColor product.[2]

- GOES-19 imagery with a GeoColor overlay indicates mature convection over ON.

- However, the GeoColor masks the locations of wildfires. This makes it difficult to infer pyroconvection.

Figure 1b. GOES-19 (East) satellite imagery of a pyroCb triggered by a wildfire southeast of Pikangikum, ON (51.58°N, 93.81°W), on July 10, 2025, at 21:00 UTC. Satellite imagery is overlaid with an RGB Fire Temperature product.[2]
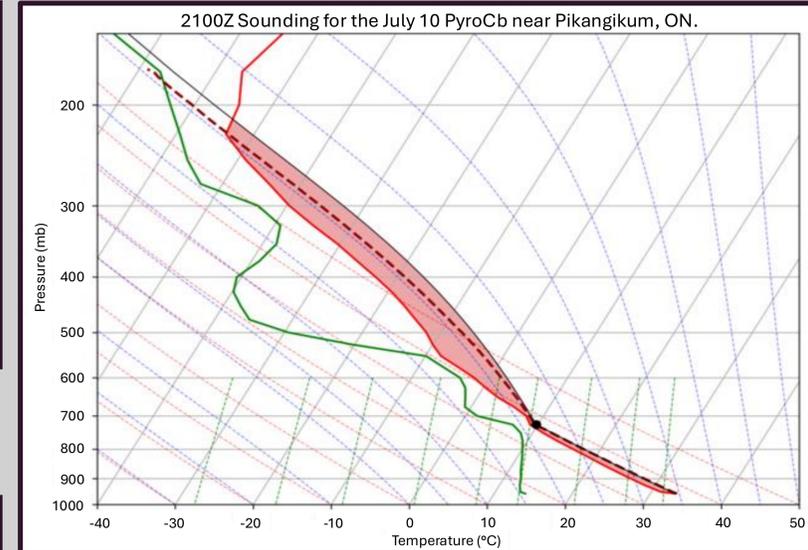
- Using an RGB Fire Temperature overlay, a wildfire is revealed underneath the base of the storm.

- The close-proximity of the wildfire indicates that the storm is likely a pyroCb.

Figure 2. Skew-T diagram for the pyroCb southeast of Pikangikum, ON., on July 10, 2025. Sounding valid for 21:00 UTC. Adapted from Mallia, D. (2025).[7]

- Classic "inverted-V" profile from a very hot (~35°C) and dry surface (~15°C).
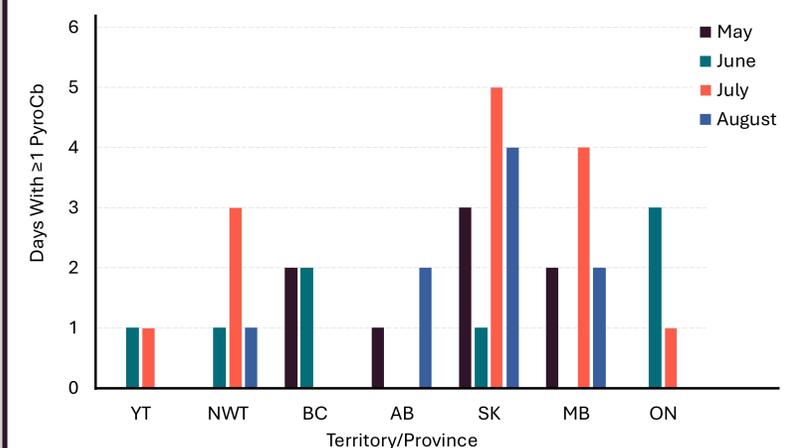- High-based storm with an LCL ~725 mb.
- Lots of CAPE.

Figure 3. Bar chart displaying the number of days with at least 1 pyroCb observed per month (May to August) in the Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, and Ontario in 2025.

- 39 potential pyroCbs have been observed so far.
- July is the most active month (14), and Saskatchewan is the most active province (13).

5. NEXT STEPS

- Continue to run the algorithm and generate soundings

- Separate cases into mature and shallow convection

- Map pyroCbs and lightning flashes in QGIS

- Compare pyroCb environments and lightning characteristics

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[4] Peterson, D. A., Fromm, M. D., Solbrig, J. E., Hyer, E. J., Surratt, M. L., & Campbell, J. R. (2017). Detection and inventory of intense pyroconvection in Western North America using GOES-15 daytime infrared data. *Journal of Applied Meteorology and Climatology, 56*(2), 471–493. https://doi.org/10.1175/JAMC-D-16-0226.1
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